Preparation of Lapsi *(Choerospondias axillaries roxb.)* Pulp Stock using IMF Technology and Study for Storage Stability and Food Safety Aspects

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Abstract

The work was carried out to study the storage stability and food safety aspects of lapsi (Choerospondias axillaries roxb.) pulp stock prepared using Intermediate Moisture Food Technology. Three recipes were designed with the TSS of 55, 60 and 65 ^{o}Bx and the TSS/Acidity ratio of 20, 25 and 30 respectively so as to achieve the theoretical water activity level of 0.86 to 0.90. Further three treatments using no preservative, potassium sorbate (0.3%) as preservative and pasteurisation with hot filling were done to those recipes.

All samples were found to be safe from the food poisoning organism Staphylococcus aureus. All preservative added and pasteurised samples as well as 65 ^{o}Bx sample with no preservative were stable up to 5 months storage and no Mold growth were observed. Mold observed after 2 month in 55 ^{o}Bx sample and after 69th day in 60 ^{o}Bx sample with no preservative. Preservative added samples were faint in colour while pasteurised samples were dark due to browning reaction during heating. No preservative used sample was best in appearance. 65 ^{o}Bx with no preservative sample was good design but protection from air to prevent browning and use of sorbate to further extend shelf life was found necessary.

Introduction

Lapsi is found in middle hills of Nepal at an elevation from 1300 to 1800 m. (Vaidya, 1994). These trees are 10-15 m. tall, graceful and deciduous and leave of odd-pinnate (Regmi, 1982). Tree bears fruit in a year during the month of November to January. A fruit lie between cylindrical and oval in shape and has an olive green coloured peel covering a white fleshy pulp, firmly attached all around the stone. The average size of matured fruit ranges from 1-1.5 inch in length and 0.75-1.9 inch in diameter (Shah, 1978).

Table-1: Nutritional composition of Lapsi pulp

Parameters	***Per 100gms***
Edible portion	59 %
Moisture	79.9 gms
Protein	0.5 gms
Fat	0.02 gms
Minerals	0.5 gms
Fibre	1.4 gms
Carbohydrates	17.68 gms
Energy	73.6 k.cal.
Calcium	218 mgs
Phophorus	20.6 mgs
Iron	2.7 mgs
Vitamin C	48 mgs

Source: Food Composition Table, National Nutrition Programme, DFTQC / HMG

Intermediate Moisture Foods:

IMFs are characterized by a moisture content of around 15-50 % and an a_w between 0.60 and 0.85 by the use of additives such as glycerol, glycols, sorbitol, sucrose and so forth, as humectants and by their content of fungistats such as sorbate and benzoate.

The following general techniques are employed to change water activity in producing an IMF-

a. <u>Moist Infusion</u>- Solid food pieces are soaked and / or cooked in an appropriate solution to give the final product the desired water level (desorption).
b. <u>Dry infusion</u>- Solid food pieces are first dehydrated and then infused by soaking in a solution containing the desired osmotic agents (adsorption).
c. <u>Component blending</u>- All IMF components are weighed, blended, cooked and extruded or otherwise combined to give the finished product the desired a_w.
d. <u>Osmotic drying</u>- Foods are dehydrated by immersion in liquids with a water activity lower than that of the food. When salts and sugars are used, two simultaneous counter current flows develop: solute diffuses from solution into food and water diffuses out of the food into solution (Jay, 2000).

The general water activity range of IMF products makes it unlikely that gram-negative will proliferate. This is true also for most gram-positive bacteria with the exception of cocci, some spore formers and lactobacilli.

Staphylococcus aureus is the only bacterium of public health importance that can grow at a_w values near 0.86. Staphylococci may be expected to exist at least in low numbers in any or all food products that are of animal origin or in those that are handled directly by humans unless heat-processing steps are applied to effect their destruction. (Jay, 2000).

With respect to mold in IMF systems, a large number of molds are capable of growth in the 0.80 range, and the shelf life of IM pet foods is generally limited by the growth of these organisms.

In Nepal, mostly in Newari Kitchen lapsi is usually consumed either in the form of *chatani* or pickle as an appetizing agent after the end of traditional Newari *Bhoj*. Like wise, other traditions of Nepalese are also becoming habitual to use this seasonal fruits in their kitchen to prepare *chatani* and pickle by their own costumes. Regarding this fact in mind, the present study is aimed to develop a suitable appetizing product "lapsi pulp stock" that can be used for extended period of time so as to meet or satisfy the need of every household of Nepalese culture and tradition.

The objective of present work is to study the storage stability and food safety aspects of lapsi pulp stock prepared using IMF technology.

Materials and Methods

Lapsi was obtained form the local market. It was washed with water and sorted out the defective pieces and other contaminates. Then, it was boiled in water (1:1 ratio) until the skin broken down and then cooled to room temperature. The skin was removed and pulping was done. Stone was removed form pulp. Pulp was then, mixed with weighed amount of sugar, citric acid and salt to make the TSS of 55, 60, 65 ^{o}Bx. Then these samples were treated in three ways:

a. Kept in clean bottle and packed
b. Heat pasteurisation and hot filling in clean bottle, packaging and inverting for three minutes
c. Added 0.3% potassium sorbate, mixed and kept in bottle.

Lapsi taken
↓
Washed with water
↓
Sorting
↓
Boiled in water (1:1 ratio) until the skin breaks down
↓
Cooled
↓
Skin removal
↓
Pulping
↓
De-stoning
↓
Mixed with measured amount of sugar, citric acid and salt

↓	↓	↓
Kept in bottle	Pasteurisation	Added 0.3% Potassium Sorbate and mixed
↓	↓	↓
Storage	Hot filling in bottle	Kept in bottle
	↓	↓
	Storage	Storage

Fig. 1. Process flow chart of lapsi stock preparation with different treatments

Treatment Matrix:
The treatment matrix may be drawn as:

Treatment 1. ***Recipe****:* Recipe 1 (55^{o}Bx) (R_1)
Recipe 2 (60^{o}Bx) (R_2)
Recipe 3 (65^{o}Bx) (R_3)

Treatment 2. ***Preservative*** No preservative (N)
Potassium Sorbate (P)
Heat (H)

Table 2. Treatment matrix for the study

Treatments: -		***Recipe***	
Preservative	R_1	R_2	R_3
N	N R_1	N R_2	N R_3
P	P R_1	P R_2	P R_3
H	H R_1	H R_2	H R_3

Product Design and Recipe Calculation:

In general beverages, °Bx/Acidity ratio of 20 to 30 is considered best from consumer perception point of view. So, the product was designed in the same range. The sugar requirement was calculated to have the theoretical water activity of 0.86 to 0.92 ranges, since literature explains that sugar reduces water activity more than the theoretical value.
The formula for calculation of water activity is:

$$a_w = \frac{\text{Moles of solvent}}{\text{Moles of solute + Moles of solvent}}$$

The analysis report of pulp was:

°Bx	15
Acidity	4.95%
Moisture	80.1%

The theoretical product design of lapsi stock has been tabulated below so as to make it IM food. The °Bx/Acidity ratio has been kept in between 20 to 30 and theoretical water activity level has been kept in between 0.86 to 0.90.

Table 3. Theoretical Product design

Parameter	*Recipe 1*	*Recipe 2*	*Recipe 3*
°Bx	55	60	65
Acidity	2.8	2.5	2.28
a_w (Theoretical)	0.90	0.88	0.86

Recipes have been calculated using the principle of material balance so as to achieve the theoretical product design. Material balance was done for each component (Sugar, Salt, Acid and Total). The calculated recipes have been tabulated below.

Table 4. Calculated recipes of lapsi stock using material balance

Materials	*Recipe 1*	*Recipe 2*	*Recipe 3*
Pulp (gm)	550	482	424
Sugar (gm)	410	476	528
Salt (gm)	38	42	47
Acid (gm)	-	0.6	1.2
Total (gm)	1000	1000	1000

After material balance recipes were designed. Water activity of these three recipes has been calculated as in the table below:

Table 5. Calculation of theoretical water activity level of different recipes

Recipe	*Amount per Kg product*								*Calculated water activity*
	Water		*Sugar*		*Salt*		*Citric Acid*		
	(gm)	*(moles)*	*(gm)*	*(moles)*	*(gm)*	*(moles)*	*(gm)*	*(moles)*	
1	440	24.44	493	1.44	38	0.67	27.2	0.39	0.907
2	386	21.42	548	1.6	42	0.74	24.6	0.35	0.888
3	339	18.83	592	1.73	47	0.83	22	0.31	0.867

Theoretically, water activity of the designed product is in the range of 0.86 to 0.90. Sugar reduces the water activity level more than the theoretical value (Jay, 2000). Hence, practically the water activity level of the product will be lesser than that calculated one. Therefore, the product will fall in the desired water activity level of IM foods. The product can be considered IM foods with sugar as major humectant.

Analytical methods

^{o}Bx and pH were analysed using hand refractometer and pH meter respectively. Acidity as citric acid was calculated by titration method and reducing sugar was analysed by Fehling's method.

Results

The yield of different portion has been tabulated below. The percentage yield of pulp, stone, and peel was found to be 41.4, 24 and 20 respectively. The remaining 14.6% was lost during boiling due to moisture loss and soluble solid loss in water.

Table 6. Percentage yield of different portion of lapsi

S.N.	*Portion*	*Percentage yield*
1.	Pulp	41.4
2.	Stone	24.0
3.	Peel	20.0

The analytical report of different recipes has been tabulated below. The report was very close to the theoretical product design.

Table 7. Analytical Report of different samples

Parameters	*Recipe 1*	*Recipe 2*	*Recipe 3*
^{o}Bx	55	60	65
Acidity (as citric acid)	2.72	2.46	2.11
pH	2.89	2.93	2.96
Reducing sugar	8.67	7.30	6.15
^{o}Bx/ acidity	20.22	24.39	30.80

Storage Study:

After one month storage:

- Mould count was negative in all recipes.
- *Staphylococcus aureus* count was negative for all recipes.

After two months storage:

- Mold growth occurred in NR_1 product
- No Mold growth in NR_3 product
- No Mold growth in all samples of heat treated as well as chemical treated product
- Mold growth started in NR_2 product after 69th day of preparation.

After three months storage:

- Two colonies being observed in NR_2 product
- No Mold growth in NR_3 product.
- No Mold growth in all samples of heat-treated as well as chemical treated product.

After five months storage

- No Mold growth in all heat treated as well as chemical treated product
- No Mold growth in all NR_3 samples

After six month

- No mold growth in all chemical treated products.
- Mold growth in 66% of HR1 and no mold growth in HR2 and HR3
- No mold growth in all NR3 samples but brown ring at top with liquid exudates and slight off-flavour.

Since the browning reaction rate is very high at water activity of IMFs food, the browning reaction become prominent when pasteurised and maximum temperature attained was only 78 ^oC. The pasteurised product resulted very brown appearance.

Discussion

Preservative added samples became bad in appearance, faint in colour, whiteness due to difficulty of solubilisation of sorbate in product in high sugar concentration. It is necessary to dissolve sorbate at first in pulp and then other ingredients should be added.

Browning was prominent during the pasteurisation of product due to high reaction rate at water activity of IM food. The product resulted very brown appearance. Neither heated nor preservative added product had very appetizing and good appearance.

The pH of the product is in the range of 2.8 to 3.0. *S. aureus* is a mesophile and its growth occurs over the range 7 to 47.8 ^oC and enterotoxins are produced between10^oC and 46^oC, with the optimum between 40^oC and 45^oC. It can grow well in 7-10% salt concentrations and some strains can grow in 20 %. It can grow over the pH range of 4.0-9.8 but its optimum being in the range of 6-7 and a_w of 0.86 is generally recognized minimum value for growth. Growth was not observed in brain heart infusion (BHI) broth containing NaCl and sucrose as humectants either at pH 4.3, a_w of 0.85, or 8 ^oC or with a combination of pH < 5.5, 12^oC and a_w of 0.90; and pH < 4.9, 12^oC and a_w of 0.96 (Jay, 2000). Notermans and Hessvelman (1983) showed that growth of *S. aureus* is not observed at a_w 0.852 or temperature < 8^oC or pH < 4.3 (Banwart, G.J. 2002). Barber and Deivbel (1972) showed that aerobically some strains of *S. aureus* produce enterotoxin at pH of 4.87 but anaerobically enterotoxin is found at pH 5.4. *S. aureus* grew and produced enterotroxin in precooked bacon stored aerobically either at 37^oC and minimum a_w of 0.84 or at 20^oC and an a_w of 0.89 by Lee, Silverman and Munsey(1981). Anaerobically the organism required a minimum a_w of 0.98 at 37^oC and 0.94 at 20^oC. Similarly, Mclean, Lilly and Alford (1968) showed that above 2% salt concentration, enterotoxin production decreases and becomes minimum above 4% salt concentration (Banwarat, G.J. 2002).

The pH range of the product is 2.8 to 3 and salt concentration is 3.8 to 4.7% with a_w of 0.86 to 0.91. The analysis of product also showed no growth of *S. aureus* in product during storage. Hence the product is safe from public health importance bacteria.

Mold growth was the problem for sample with no other hurdles. Storage study showed that Mold growth started after 2 months in 55^{o}Bx product with no preservative that occurred after 10 weeks in 60^{o}Bx with no preservative but not occurred in 65^{o}Bx until five months storage. With respect to Mold in IMF systems, these products would be made quite stable if a_w were reduced to around 0.70, but a dry type product would then result. A large number of Molds are capable of growth in the 0.80 range, and the shelf life of IM foods is generally limited by the growth of these organisms. Acott *et. al*. (1976) showed that growth of *Aspergillus niger* and *A. glaucus* occurred in 2 weeks in the a_w 0.85 formulation without inhibitors but did not occur until 25 weeks when potassium sorbate and calcium propionate were added (Jay, 2000).

Vacuum packaging may be another option for the preservation, since the major problem is Mold growth. Further research is necessary to study the effect of vacuum packaging and / or required amount of preservative required for self-stabilization. It can be assumed that product NR_3 is stable from Mold for further five months after opening the vacuum packed product.

Conclusions

Lapsi pulp stock can be prepared and stored safe with recipe of 65^{o}Bx, and acidity of 2.11% using sugar as a major preservative for at least five months if hygienic conditions are maintained but use of preservative like sorbate and protection from air is necessary to prevent browning and to increase shelf life further. The product is safe from public health important microorganism.

The product can be used to prepare beverage by diluting with water and addition of spices as per requirements or may also be used to prepare other lapsi products such as candy since the sugar and pulp ratio is optimum for them as well. Again it can be used to prepare lapsi relish with the addition of spices as per requirement. The stock could be marketed for the lean period of lapsi in the market.

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